Classroom Assessment Techniques for Teachers of Senior Science Subjects

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Abstract

Combining school-based assessments with examination results in an attempt to gain more valid evaluations of student abilities is not a new idea. However, the ways in which the idea is implemented can vary from place to place. Beginning in 1993, teachers of the three science subjects offered by the PSSC (Pacific Senior Secondary Certificate) system - now used in five Pacific Island countries - will be required to follow a number of rules regarding the internal, or school-based, assessment of their students. In order to help science teachers with some of the measurement tasks they will be expected to carry out, the examining authority has published a teachers' guide. This article provides some background about this move and presents sections of the guide that may be useful to a wider range of science teachers.

Introduction

The Pacific Senior Secondary Certificate (PSSC) is unique in our part of the world in that it is an educational accreditation system that originated in the region, is increasingly run by regional people, and is currently used in five Pacific-island states (Solomon Islands, Kiribati, Tonga, Vanuatu and Western Samoa). The system is coordinated and maintained by the South Pacific Board for Educational Assessment (SPBEA) - an organization set up, partially financed, and governed by 10 member countries. There are nine PSSC subjects available to students (Biology, Chemistry, Physics, Mathematics, Geography, History, Economics, Accounting and English) who are normally required to study five in their twelfth year of formal education.

At the end of the year, students sit for a formal examination in the subjects they have been studying. The examinations are based on norm-referenced measurement principles - i.e., a student's achievement is defined in terms of her rank rather than in terms of some form of absolute standard. Some subjects

have always had an internal assessment (I.A.) component that contributes, together with the examination score, to students' final grades. These grades take the form of whole numbers ranging from 1 (the highest) to 9 (the lowest). Some other subjects have the assessment of students based on the examination alone, and others may or may not include an I.A. component depending on which country students come from. This last group of subjects includes the sciences (Biology, Chemistry and Physics), and has long been the topic of debate amongst those concerned with consistency of assessment from place to place within the system.

From 1993 however, assessment of student achievement in each of the sciences will include a newly-defined I.A. component that will be used by all participating countries. These new requirements are listed in an appendix at the end of this article. Suffice it to say here that science teachers will be required to submit for approval (to the SPBEA) I.A. programs that follow certain rules but also allow for a degree of independence. A common feature of all the programs will be the emphasis placed on the assessment of skills associated with 'practical work'. Indeed, for the first time, students of any of the science subjects will be required to complete a minimum number of practical activities. They will also have to write reports regarding these activities. Teachers will be required to include their marks for some of these reports as part of the total internal assessment of each student. For some time there has been concern that many teachers may not have been placing the degree of emphasis on practical activities necessary for useful and effective science education at the senior level. The new rules then, are intended to not only produce more broad-based assessments of student abilities but to also influence the style of teaching taking place in many classrooms. It is, in fact, an attempt to use the well-recognized power that assessment systems have over what is taught and how it is taught, to improve both teaching and learning.

The designing and implementing of these programs may prove difficult for many teachers - particularly those with little experience in classroom assessment techniques that go beyond simple pen and paper tests. For this reason the SPBEA has produced a booklet entitled "PSSC Internal Assessment in English and the Sciences - a Teacher's Guide". Part of this guide suggests techniques that science teachers may use in order to be more objective in their assessment of student abilities. The rest of this article is taken from that

section of the guide. Rather than being an academic treatise, it uses a practical hands-on approach aimed at science teachers. Although specifically written for the PSSC system it may be of interest to a wider population of educators.

(Quoting from "PSSC Internal Assessment in English and the Sciences - a Teacher's Guide")

Types of Assessment Tasks

Earlier in this guide an 'assessment task' was defined as any activity a student had to complete that was related to the course, and which would be assessed by the course teacher. Mention was made of two categories of such tasks - 'included' and 'formative' [those that will 'count' towards student final scores are the 'included' tasks. Those that are designed to help improve student learning but are not used in determining the final I.A. score are the 'formative' tasks]. But what types of activities are available to science teachers when designing these tasks?

Some examples are:

- Quizzes (brief tests)
- Pen-and-paper tests
- Practical tests
- Practical reports
- Research projects
- Experimental investigations
- Assignments
- Theory-based problems
- Seminars
- Essays

Some of these tasks can be readily carried out under strict teacher supervision (e.g., tests), others cannot. Also, a number of such activities may be included in the one task. For example, a student may be given a major research project

that will require some initial library research, some experimental investigation, and a detailed report. Whatever form the I.A. Tasks you design take, ensure that in each case you:

-have a clear idea of what you expect from your students,

-have related the tasks to the prescription objectives and/or content,

-give the students a clearly written description of the task,

-prepare a marking scheme (showing marks available for each skill area) together with the task description and also give this to students.

Using Checklists and Rating Tables for Assessment

I.A. Tasks should relate to course objectives. That is, they should enable specific skills and abilities to be assessed. These skills and abilities are often part of the overall objectives listed in the course prescription.
When marking assignments it is easy to simply read through the work of each student and then make a very subjective decision on the mark each assignment should receive. Such an approach to marking is not satisfactory, especially when an assignment contributes towards a student's I.A. Score. It is important that marking is objective.

Both checklists and rating tables can be used to identify specific criteria you have regarding skills being assessed in a task, and will therefore help you to be objective in your marking. The only difference between the two is that a checklist simply requires you to place a tick (✓) against each criterion if the student demonstrates the required skill or to leave it blank if he or she doesn't. A rating table, on the other hand, has a scale (i.e., a number of possible marks) for each criterion, and requires you to make a more refined judgement about where each student's skill or ability falls on the scale.

The design of a checklist or rating table will depend on the particular task and the skills and abilities being assessed. The following two examples of rating tables (figures 1 and 2) are based on particular objectives in the PSSC Biology Prescription. Figure 3 is an example of a checklist.

PRACTICAL REPORT - RATING TABLE
(This assessment is for GRAPH WORK)

	Max. Poss.		
* Suitable title	1	½	-
* Labelled axes	2	1	-
* Units of axes	2	1	-
* Accurate plotting	1	½	-
* Clear plots	½	-	-
* Axes right way around	½	-	-
* Even Scales	1	½	-
* Neat	1	½	-
* Suitable size	½	-	-
* Correct type of graph	½	-	-

TOTAL (max 10):

COMMENTS:

Figure 1:An example of a rating table that could be used to assess the section of a practical report involving graphing skills.

(This rating table could be used, for example, to assess some of the skills involved in 'recording and presenting data' - an objective stated in the PSSC Biology Prescription.)

SEMINAR - RATING TABLE

CONTENT:

LEVEL

	1	2	3	4
* Range of references used				
* Research relevant to topic				
* Information accurate				
* Examples used				

COMMUNICATION:

* Clarity				
* Fluency				
* Formal structure				
* Logical arguments				
* Interesting				
* Questions answered				
TOTAL				

Total mark ÷ 4 = mark/10

KEY:

1= unsatisfactory 3 = good
2= adequate 4 = excellent

Figure 2: An example of a rating table that could be used for assessing student seminars.

(This rating table relates to the 'locating information' and 'communicating orally' objectives in the Biology Prescription.)

Students should be shown a copy (possibly on a blackboard) of the checklist or rating table you will be using when assessing a particular I.A. Task. This will allow them to devote their energies to those areas you think important. Also, duplicate copies of the table can be made (each student could draw up their own copy) and be returned, completed, to each student after the marking process. This will show students how their total score was determined. You can probably see how checklists and rating tables lean towards the CRM [criterion-referenced measurement] approach to assessment discussed earlier in this guide [but not in this article]. Although single words or phrases may appear in the tables, these may in fact be abbreviations for more extensively specified criteria (this, however, doesn't have to be the case).

Assessing Practical Skills

Several of the key requirements for the internal assessment of PSSC Biology, Chemistry and Physics centre on skills necessary to carry out practical activities that are directly related to the course as defined in the prescriptions. Furthermore, these should be skills that cannot be easily measured during the examination. For example, an examination question may ask students to write a description of how to prepare a microscope slide of cockroach mandibles.

As a result, we can then determine whether a student knows in theory how to carry out the task. This, however, is not the same as seeing whether a student can actually prepare the slide.

The traditional examination setting does not allow for such an assessment, but a school setting does. This is why teachers will have the responsibility of assessing 'doing skills' of this kind (i.e., doing more than sitting at a desk writing) and is one of the reasons for having the "practical activities" requirement in the I.A. section of the prescriptions [see the appendix].

Practical Reports

The PSSC science prescriptions attempt to ensure that at least some practical skills will be assessed via the student practical reports (a minimum of 5 to be treated as Included I.A. Tasks) and practical tests (a minimum of one).

++The practical reports, composed and authored by students, should refer to activities that typically involved the physical manipulation of equipment, specimens, or the environment according to some predetermined procedure (which may be designed by the student); the observation and recording of results or behaviours or appearances; and the analysis and conclusions resulting from these observations. Teachers should avoid simply marking all practical reports for being complete or for having correct answers to a series of questions. Rather, one or two skills or abilities should be identified for each practical investigation and well constructed checklists or rating tables used to assess these objectively. For example, an investigation in biology, chemistry or physics which required students to gather data and use it to construct a graph could be assessed for the skill of recording and presenting data. The rating table shown in figure 1 could be used to assess this skill. Students should be informed of the skill or skills which will be assessed in any practical investigation. These practical activities must take at least one normal class period to complete and should be a regular part of the course. The practical test is included in the requirements because student reports, although focusing on practical activities, do not let you see first-hand what a student has done. A practical test, on the other hand, allows you to observe students in action.

Practical Tests

Practical tests can be used to find out if a student has really mastered particular skills. The student is given one or more specific tasks that involve the use of scientific equipment or the application of certain skills. The teacher then assesses the student's level of skill either by observing the student carrying out the task or by checking the final result.

There are many tasks that students could be given. For example:

-connecting up a particular type of electrical circuit,

-finding the focal length of a lens (or curved mirror),

-using a ticker timer,

-finding the density of a stone,

-separating pigments by means of chromatography,

-preparing and testing for hydrogen,

-carrying out a titration,

-testing an unknown solution for starch, glucose and protein,

-dissecting an insect,

-weighing a coconut,

-preparing a microscope slide of some pond slime and setting it up under a microscope,

-designing an experiment to test a given hypothesis,

e.g., * that the volume of liquid in a coconut decreases as the coconut gets older,

* that a fishing line is weaker if it has a knot in it,

* that pigs have set sleeping and foraging times,

* that the daily temperature changes that occur in coral sand and soil will be similar.

(Remember: Do not include a task in a practical test unless students have been taught the general principles related to that task. However, it would be possible to give a student an experiment that had not previously been studied if you were assessing the ability to follow instructions or if the student had completed an earlier experiment that was based on the same principles.)

Practical tests are excellent for assessing practical skills and students usually find them enjoyable and stimulating. Designing and setting up a good practical test will take some time and careful planning. Marking the test, on the other hand, is usually quite simple.

The easiest practical test to design would be one where all students are given the same practical task (e.g., one from the list above) and have a set time to complete it. In reality such an approach is often not possible as there may not be sufficient equipment for each student or it could be too easy for students to see what others are doing. Such problems can be overcome by having just a few students doing the task while the rest of the class is working unsupervised in another room, or by taking students aside one at a time and having them carry out a particular task while you watch and assess their performance. In this case the rest of the class would be continuing with set work in the same room.

With practical tests involving a single task, a checklist can be designed to quickly assess each student. Figure 3 shows a checklist that could be used with a practical test in biology where students are asked to prepare a microscope slide of some pond slime, set up their slide under a microscope and focus it on low power.

Slide Preparation and Microscope Use - Checklist

	Names								
* Slime spread out									
* Coverslip present									
* No water on top of coverslip									
* No air bubbles or few air bubbles									
* Mirror adjusted									
* No water on stage									
* Correct magnification									
* Slime in field of view									
* In focus									
TOTAL/9									

Figure 3.A checklist designed to be used with a particular practical test.

This checklist could be easily modified (e.g., if different material was being used or if students were asked to use a stain) or extended (e.g., if they were also required to draw a diagram of what they saw down the microscope).

Another type of practical test that overcomes the problems of limited equipment and collusion between students but can still be sat by a whole class, is the 'station-type' practical test. In this type of test several 'stations' are set up around the room. At each station there is an instruction card telling the student exactly what to do and all the equipment that will be required. Each station has instructions for a different task. The number of stations will depend on the time each task will take and the total time available for the test. e.g., If 5 minutes is given for each task then a lO-station test could take 50 minutes to complete. If there were more than 10 students in the class it would be necessary to either:

-add more stations and make the test longer,

-add more stations but reduce the time spent at each station so that the test will still take the same time,

-set up an identical test in another room.

Station-type practical tests take time to set up but are easily controlled by a single teacher. The following steps should be followed:

-students should be given clear instructions about the test before entering the room,

-ideally, each student should be given an answer sheet designed specifically for the questions in the test (this will help prevent confusion and will also make marking much easier),

-students enter the room and one student occupies each station,

-each student spends the allotted time on the task at his or her station,

-the teacher signals 'time up' and all students move to the next station,

-the test ends when all stations have been visited by each student.

Appendix

Additions to the PSSC Physics Prescription (almost identical additions apply in Biology and Chemistry).

Internal Assessment

1 There are a number of benefits that can result from a well-designed school-based assessment scheme. However, the two major purposes of any PSSC internal assessment program are to:

> (i) measure subject-related skill and abilities that cannot easily be measured by pencil-and-paper tests (e.g., certain practical skills in science subjects, long-term research and investigative skills, etc.),
>
> (ii) measure the same skills and abilities that the end-of-year examination attempts to measure; the justification for this being that repeated assessment is likely to be more accurate and fair than assessment based on a single examination.

These should be kept in mind when designing such a program for submission to the SPBEA.

2 The PSSC Internal Assessment will be weighted as 40% of the total assessment. The final examination will be weighted as 60% of the total assessment.

3 At least fifteen (15) practical activities directly related to course objectives and content, as described in this prescription, each practical requiring at least one normal class period to complete, must be carried out by each student. Students must also write a report on each of these activities. This is a prerequisite for sitting the final examination.

4 A large but undefined fraction of the PSSC Internal Assessment will be based on skills required for successfully carrying out subject-related practical activities that cannot easily be measured in a single, end-of-year examination. Specifically, half (50%) of the Internal Assessment will be based on the

assessment of a minimum of five (5) student practical reports - the same five for each student.

5 The remaining half (50%) of the Internal Assessment will be based on the assessment of a minimum of five (5) assessment tasks other than the regular practical reports. At least one of these tasks must be a practical test. The other tasks may be, for example, further practical tests, other types of test, assignments, research projects, seminars, etc. These tasks may also require practical skills.

6 Although it is recognized that certain general student attitudes and behaviours may be desirable (e.g., co-operativeness, perseverance, politeness, etc.) these should not play any part in the PSSC Internal Assessment Program submitted by any school. Attempts to quantify and report such qualities should be done as a separate school activity.

7 Schools that intend to enrol students in PSSC Physics must submit a completed **"PSSC Internal Assessment Summary Form"** by March 1st in the year of enrolment. These forms will be provided by the SPBEA. Several forms may be necessary to document a school's Internal Assessment Program. Further information must also be attached to these forms. This information should include details about procedures and the marking of separate assessment tasks, and descriptions of intra-school moderation of internal assessments if a school has more than one class following PSSC Physics.

8 Schools must supply a single mark out of 100 (i.e., 100 is the maximum possible score) for every enrolled student - this mark being directly based on the school's SPBEA-approved PSSC Internal Assessment Program.

9 Clear records and documentation regarding the school's approved PSSC Internal Assessment Program must be kept. Furthermore, all student work that has been assessed under this program (tests, essays, practical reports, projects, etc.) must be available for verification by SPBEA officers during any one school year.

10 Students who will be enrolled in PSSC Physics must be given a copy of the school's PSSC Internal Assessment Program for the subject. Each student

must also be informed of when assessment tasks are to be given, and be notified of his or her assessment result for each task as soon as it is determined.

11Relevant teachers and school principals will be required to sign the **"PSSC School Agreement"** form to confirm that the above PSSC Internal Assessment rules will be followed. Non-adherence to these rules may cause students to be removed from PSSC enrolment in some subjects.

Note: Advice to teachers on how to design an Internal Assessment Program is contained in the SPBEA booklet **'PSSC Internal Assessment in English and the Sciences - a Teacher's Guide'.**

References

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